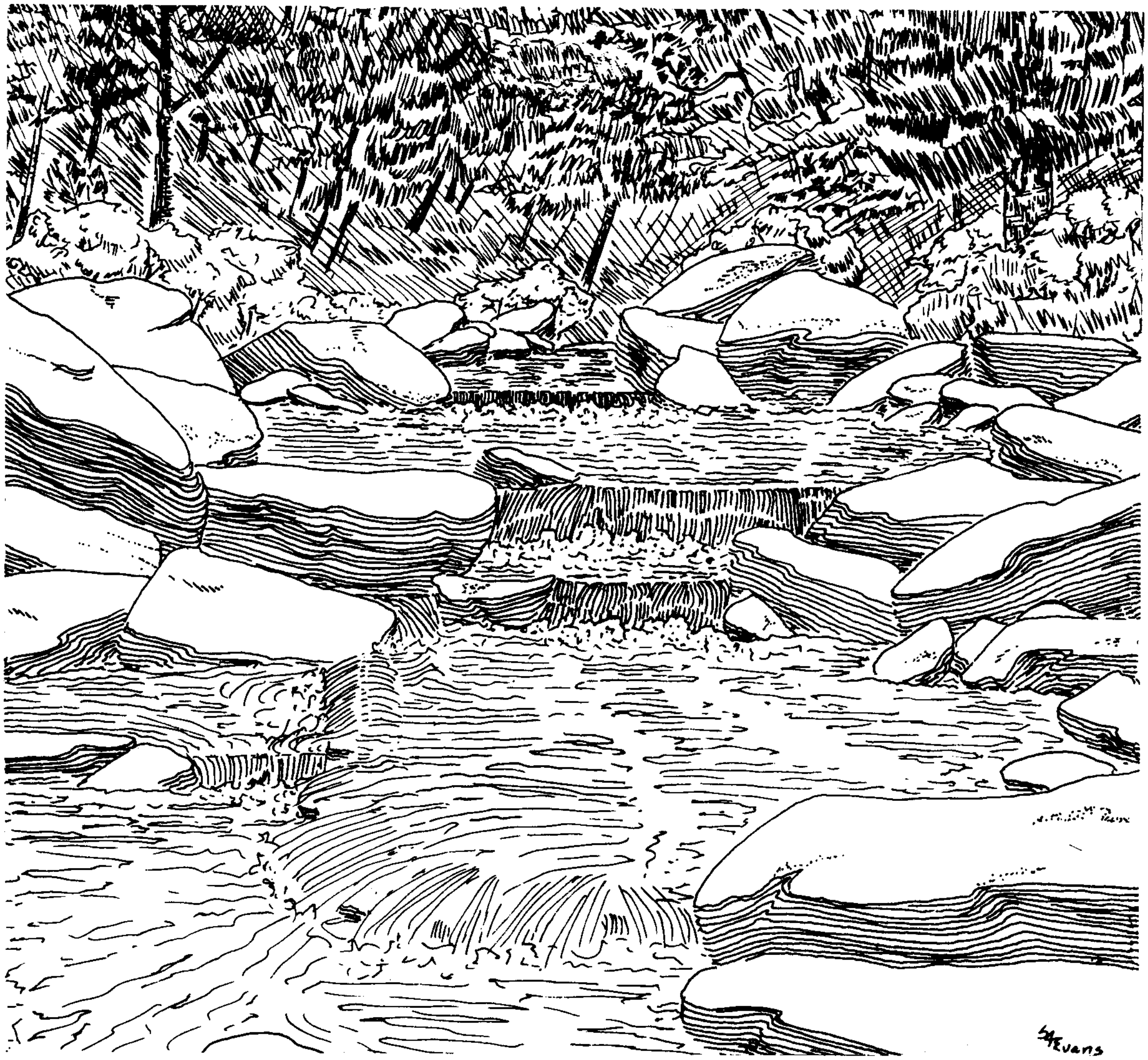
1986 KENTUCKY REPORT TO CONGRESS ON WATER QUALITY



Commonwealth of Kentucky
Kentucky Natural Resources and
Environmental Protection Cabinet
Division of Water

1986
KENTUCKY
REPORT TO CONGRESS
ON
WATER QUALITY

COMMONWEALTH OF KENTUCKY
NATURAL RESOURCES and
ENVIRONMENTAL PROTECTION CABINET
DEPARTMENT FOR ENVIRONMENTAL PROTECTION

DIVISION OF WATER

MAY, 1986

LIST OF TABLES

ACKNOWLEDGEMENTS

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EXECUTIVE SUMMARY

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This report has been prepared pursuant to Section 305(b) of the Federal Water Pollution Control Act of 1972 (P.L. 92-500), as amended by the Clean Water Act of 1977 (P.L. 95-217). This biennial report presents an assessment of Kentucky's water quality conditions and trends for the period 1984 through 1985. Also discussed are special water quality concerns and the status of the state water pollution control program.

Water Quality Assessment

The water quality assessment of rivers and streams in Kentucky's 1986 report is based on those waters depicted on the 1974 U.S. Geological Survey Hydrologic Unit Map of the state. Of the 18,500 stream miles displayed on this map, approximately 5,700 miles (30.8 percent) were assessed for the reporting period 1984-85.

Based on this assessment, 45 percent of the total miles assessed experienced some degree of use impairment. Uses were not supported in 675.3 miles (11.9 percent of the assessed miles), comprising 45 stream segments across the state. The major causes of use impairment were pollution contributions from coal mining activities, oil production operations, and municipal and industrial wastewater discharges. The water quality ranking of thirty-one hydrologic units encompassing most of the state reveal that the seven watersheds with the lowest water quality ranking contain 58 percent of the stream miles not supporting designated uses. These hydrologic units include: Mud River and Pond River within the Green River basin; the northern half of the Salt River basin; the upper mainstem of the Kentucky River basin including the Red River; Tug Fork and Blaine Creek within the Big Sandy River basin; and the Little Sandy River.

Results of a trend analysis performed on data collected at ambient monitoring stations since 1980 indicate that there were no stations with declining water quality over the assessed period. Five locations showed improving water quality: Pond Creek near Louisville, Kentucky River at Camp Nelson and below Frankfort, Nolin River at White Mills, and the South Fork of Cumberland River. Major pollutants of primary concern include heavy metals (iron, lead, copper, and zinc), fecal coliform bacteria, total suspended solids, phosphorus, PCBs, chlordane, and chloride.

The water quality assessment of lakes includes more than 90 percent of the publicly-owned lake acreage in Kentucky. Of the 362,403 acres assessed, 326,483 acres (90 percent) support designated uses. The five lakes constituting the 573 acres not supporting designated uses are McNeely, Carpenter, Corbin, Loch Mary, and Sympson.

Natural conditions contribute to 77 percent of the documented use non-support in lakes. This is largely due to impacts on domestic water supplies from hypolimnetic water released from large reservoirs which contains excessive levels of iron and manganese. Nonpoint sources are the second largest cause of use impairment (17 percent). Sedimentation from surface coal mining is by far the most significant nonpoint source pollutant. Another pollutant of growing concern is brine discharged from oil producing facilities. Major lakes threatened by brine pollution have a combined surface area of 20,921 acres.

There have been improvements in lake water quality over the reporting period. Reformatory Lake has become less eutrophic due to the implementation of better livestock waste handling practices within its watershed. McNeely Lake no longer has a duckweed problem because grass carp stocking has effectively controlled its growth.

As a result of the implementation of a toxics control strategy during 1984-85, a partial assessment was made regarding the extent of toxic substances in the state's waters. The results of acute and chronic toxicity tests below 15 municipal and industrial wastewater discharges indicate that a total of 155 stream miles are being adversely impacted. During 1985, fish consumption advisories were issued for two streams because of the presence of PCB's from industrial sources. The streams involved are 68.7 miles of the Mud River system in Logan, Butler and Muhlenberg counties, and 46.8 miles of the West Fork of Drakes Creek in Simpson and Warren counties. Another toxic pollutant that is emerging as a potential health threat is chlordane, which has been detected in fish tissue and sediment samples at a number of stream stations. Toxics are not considered to be a problem in any state lakes.

With some exceptions, the quality of Kentucky's groundwater is good. An increasing public awareness of groundwater and its vulnerability is serving to mitigate problems in many areas. Potentially serious problems are encountered in the karst areas. The Mammoth Cave system has been affected already, and conditions will only worsen unless stringent controls are imposed upon facilities located above karst aquifers.

Special State Concerns

The issue of brine discharges from oil production facilities intensified during the reporting period. Documented impacts to streams in the eastern oil production region indicate that uses are not fully supported in 191 stream miles due to brine discharges. A number of state and federal actions were initiated during 1984-85. The effect of a court-imposed settlement with the oil and gas industry and/or state and federal enforcement actions should be closely monitored over the coming year.

There are a number of groundwater contamination and depletion incidents that underscore the need for an effective groundwater management program. The PCB contamination incidents previously mentioned occurred in a karst region of the state. In the Drakes Creek watershed, the PCB's were originating from an industrial discharge to a sinkhole. Cities such as Elizabethtown and Georgetown are undergoing rapid economic development and depend on groundwater for community water supplies. These supplies come from karst aquifers which are very susceptible to pollution. The trend toward use of groundwater heat pump systems for large office buildings may cause a depletion of the Louisville aquifer. Bowling Green has a history of point and nonpoint source groundwater pollution problems associated with industrial, urban, and agricultural activities over major karst aquifers.

The loss of wetland resources and adverse impacts to remaining areas are of concern. It is estimated that half of Kentucky's original wetland acreage is gone. Nearly all of the remaining areas have been degraded by pesticides, acid mine drainage, siltation, oil brine, or domestic and industrial wastes. A major threat to Kentucky wetlands is their destruction by competing land use activities and poor land management practices.

Potential problem areas reflected in fecal coliform data from the monitoring network are streams not supporting the state's recreational use. A total of 323 stream miles significantly exceeded the water quality criteria associated with the primary contact recreation use during 1984-85. If future studies indicate that a significant health threat exists, advisories and posting of affected stream reaches will be considered during the recreational season.

During 1984-85, 62 fish kills attributed to pollution were reported, affecting approximately 154 miles of streams. Cutshin Creek in Leslie County has had recurring kills from oil production and mining operations over the last four years.

Water Pollution Control Programs

Significant strides were made during 1984-85 in reducing the backlog of unissued discharge permits. Efforts to incorporate toxicity-based effluent limits on new and reissued permits were increased. The Kentucky pretreatment program is well underway. A total of 49 Publicly-Owned Treatment Works have local programs approved by either federal or state authorities.

The Construction Grants Program has resulted in the construction of $113 million in wastewater projects which came on line during 1984-85. Twenty-two municipal wastewater projects were completed and an additional 42 projects are in various stages of construction. The Division of Water has been pursuing several approaches for meeting the current and projected wastewater treatment needs in Kentucky. Three such areas are: innovative treatment for small communities, cost control, and innovative financing mechanisms.

During 1984-85, enforcement activities resulted in 228 legally enforceable compliance orders and collection of $126,950 in civil penalties. Kentucky began implementation of a State Municipal Strategy in January, 1984, in accordance with EPA guidelines.

Kentucky's nonpoint source assessment was completed in April, 1984. The purpose of the assessment was to determine the extent and severity of pollution caused by agriculture, silviculture, mining and construction in waters of the state. A Nonpoint Source Pollution Program has been instituted in Kentucky. Education programs, incentives, and increased technical assistance will be used to encourage the implementation of appropriate best management practices. Although most of the state's program is voluntary, there is a strong commitment for implementation on the part of local and state government officials, the general public, the affected industries, and numerous private and public sector associations.

The development of a comprehensive groundwater management program was mandated by the Water Management Plan approved by the Governor in November, 1984. Since that time, the Division of Water has initiated such activities as: the development of a groundwater data base; implementation and administration of the state water well drillers program; identification and classification of Kentucky's aquifers; and development of a statewide groundwater policy/strategy.

Thirty-nine primary ambient monitoring stations were operated by the Division of Water during the reporting period which characterized approximately 1,777 stream miles. Biological monitoring was performed at 21 of these locations. In addition, a state lake monitoring program was initiated on six lakes for eutrophication trend assessment and on three lakes for acid precipitation trend assessment. Ten intensive surveys were conducted on 364 miles of streams for the purposes of evaluating industrial and municipal wastewater impacts and assessing use attainability.

The Water Watch Program was begun in 1985 to encourage public participation and volunteer support for various water pollution control efforts. The program trains local volunteers in water quality assessment, and the monitoring, protection and enhancement of streams, lakes and wetlands. Twenty-three training programs certifying 410 volunteers across the state were conducted in the latter part of 1985. Volunteers have adopted over 75 stream, lake, and wetland areas for monitoring.

BACKGROUND

BACKGROUND

This report was prepared to fulfill the requirements of Section 305(b) of the Federal Water Pollution Control Act of 1972 (P.L. 92-500) as amended by the Clean Water Act of 1977 (P.L. 95-217). Section 305(b) requires that states submit a report to the U.S. Environmental Protection Agency (EPA) every two years which addresses current water quality conditions. Other items to be addressed in the report include an assessment of the degree to which nonpoint sources of pollutants affect water quality, an assessment of state groundwater quality, an assessment of the extent to which the state's waters meet the fishable/swimmable goals of the Act, and recommendations on additional actions necessary to achieve the water quality objectives of the Act. EPA uses the reports from the states to apprise Congress of the current water quality of the Nation's waters and recommends actions which are necessary to achieve improved water quality. States use the reports to provide information on water quality conditions to the general public and other interested parties.

This report follows the guidance document that EPA provided to the states for the 1986 report. The stream water quality in this report is based on those streams shown on the U.S. Geological Survey's Hydrologic Unit Map of Kentucky (scale 1:500,000). The assessments were based on this map's approximately 1,300 streams and rivers which contain about 18,500 stream miles. Kentucky is divided into 42 cataloging units, 31 of which make up the 12 river basins assessed in this report. These drainage basins from east to west are the Big Sandy, Little Sandy, Tygarts, Licking, Kentucky, Upper Cumberland, Salt, Green, Tradewater, Lower Cumberland, Tennessee and Mississippi. The Ohio River Valley Water Sanitation Commission (ORSANCO) compiles a report on the Ohio River which is used as a supplement to the 305(b) reports submitted by the member states of the Commission. The assessment of lake conditions is based largely on data collected by the Division of Water in 1981-1983 under the Federal Clean Lakes Program. More recent data were utilized, when available, to update that information base. The 92 lakes which were assessed have a total area of 362,403 acres. This includes the total acres of Barkley, Kentucky and Dale Hollow lakes which are border lakes with Tennessee.

Kentucky's population, according to the 1980 census, is 3,660,257. The state has an approximate area of 40,598 square miles. It is estimated that there are approximately 40,000 miles of streams within the borders of Kentucky which ranks the state seventh in total length of streams within the contiguous United States. Kentucky has 849 miles of border rivers. The northern boundary of Kentucky is formed by the low water mark of the northern shore of the Ohio River and extends along the river from Catlettsburg in the east to the Ohio's confluence with the Mississippi River near Wickliffe in the west (a length of 664 miles). The southern boundary is formed by an extension of the Virginia-North Carolina 1780 Walker Line which extends due west to the Tennessee River. Following the acquisition of the Jackson Purchase in 1818, the $30^{o}36'$ parallel was accepted as the southern boundary from the Tennessee River to the Mississippi River.

Kentucky's eastern boundary begins at the confluence of the Big Sandy River with the Ohio River at Catlettsburg and follows the main stem of the Big Sandy and Tug Fork southeasterly to Pine Mountain for a combined length of 121 miles, then follows the ridge of Pine and Cumberland mountains southwest to the Tennessee line. The western boundary follows the middle of the Mississippi River for a length of 64 miles and includes several of the islands in the Mississippi channel.

The climate of Kentucky is classified as continental temperate humid. Summers are warm and humid with an average temperature of 76°F, while winters are moderately cold with an average temperature of 34°F. Annual precipitation averages about 45 inches, but varies between 40 to 50 inches across the state. Maximum precipitation occurs during winter and spring with minimum precipitation occurring in late summer and fall.

CHAPTER I

WATER QUALITY ASSESSMENT

RIVERS AND STREAMS

Status

Water quality conditions reported for rivers and streams in Kentucky are based primarily on the following categories of information: (1) Primary Monitoring Network data, including chemical, physical, and biological assessments; (2) intensive watershed surveys; and (3) Kentucky Department of Fish and Wildlife Resources reports. Table 1 provides a summary of designated use support during the reporting period 1984-85. The table indicates that of the 5,682.8 miles assessed, approximately 45 percent experienced some degree of use impairment. It should be noted that all surface waters of the Commonwealth have been assigned an aquatic life use (either warmwater or coldwater aquatic habitat) and a recreational use (primary and secondary contact recreation). Therefore, the summary of designated use support in Table 1 also reflects the degree to which waters are meeting the fishable/swimmable goal of the Clean Water Act.

Table 1

Summary of Designated Use Support

Basin	Miles Assessed	Miles Supporting Use(s)	Miles Partially Supporting Uses	Miles Not Supporting Uses	Miles Not Assessed
Big Sandy	308.4	41.5	186.6	80.3	904.9
Little Sandy	83.9	23.8	32.1	28.0	276.3
Tygarts Creek	113.0	110.0	3.0	0.0	81.3
Licking	323.1	228.5	70.2	24.4	1,714.0
Kentucky	902.4	640.2	139.1	123.1	2,547.8
Upper Cumberland	520.1	343.6	151.9	24.6	1,641.3
Salt	747.8	336.6	305.6	105.6	804.2
Green	1,477.9	989.4	301.6	186.9	2,053.5
Tradewater	270.3	73.8	121.1	75.4	249.4
Lower Cumberland	30.6	30.6	0.0	0.0	665.6
Tennessee	48.1	22.4	25.7	0.0	320.4
Mississippi	16.5	0.0	16.5	0.0	355.6
Ohio (Minor tribs)	176.8	101.3	75.5	0.0	1,272.9
Ohio (Mainstem)*	663.9	188.4	448.5	27.0	0.0
STATE TOTAL	5,682.8	3,130.1	1,877.4	675.3	12,887.2

*Assessment provided in 1986 ORSANCO 305(b) Report.

Table 2 provides a more detailed listing of stream segments not supporting their designated uses. River basin maps displaying designated use support information are presented in Figures 1 through 8. A more extensive discussion of river basin and hydrologic unit characteristics and conditions is presented in Appendix B.

Table 2

List of Streams Not Supporting Uses

Basin	Hydrologic Unit #	Stream	Miles Not Supporting Uses	Cause
Big Sandy River	05070204	Big Sandy River	26.8	mining, oil brines
		Blaine Creek	53.5	oil brines
Little Sandy River	05090104	Newcombe Creek	12.0	oil brines
		Middle Fork Little Sandy	12.0	oil brines
		Left Fork, Middle Fork Little Sandy	4.0	oil brines
Licking River	05100101	Burning Fork	10.0	oil brines
		State Road Fork	5.1	oil brines
		Licking River	6.3	oil brines
	05100102	Brushy Fork	3.0	industrial waste
Kentucky River	05100202	Cutshin Creek	28.8	mining
		Polls Creek	5.5	mining
		Raccoon Creek	4.9	mining
	05100204	Millers Creek	6.4	oil brines
		Billey Fork	8.6	oil brines
		Big Sinking Creek	14.1	oil brines
		South Fork Red River	11.8	oil brines
		Sand Lick Creek	5.0	oil brines
	05100205	South Elkhorn Creek	26.7	municipal waste
		Town Branch	11.3	municipal waste

Table 2

List of Streams Not Supporting Uses (cont'd.)

Basin	Hydrologic Unit #	Stream	Miles Not Supporting Uses	Cause
Salt River	05140102	Pond Creek (including North Ditch, Southern Ditch, Fern Creek)	41.0	municipal & industrial waste
		Fishpool Creek	5.4	municipal & industrial waste
		Pennsylvania Run	6.4	municipal & industrial waste
		Cedar Creek	15.6	municipal & industrial waste
		Brooks Run	6.9	municipal & industrial waste
		Chenoweth Run	9.1	municipal & industrial waste
		Salt River	21.2	municipal & industrial waste
Green River	05110001	Little Pitman Creek	10.0	municipal & industrial waste
	05110002	Drakes Creek and W.F. Drakes Creek	46.9	industrial waste
	05110003	Mud River	68.0	industrial waste
		Pond Creek	16.2	mining
		Lewis Creek	13.9	mining
	05110006	Drakes Creek	21.3	mining
		Flat Creek	10.6	mining
Cumberland River	05130101	Yellow Creek	9.0	municipal waste
	05130104	Roaring Paunch Creek	15.6	mining & oil brines

Table 2

List of Streams Not Supporting Uses (cont'd.)

Basin	Hydrologic Unit #	Stream	Miles Not Supporting Uses	Cause
Tradewater River	05140205	Caney Creek	11.3	mining
		Buffalo Creek	7.8	mining
		Clear Creek	17.7	mining
		Lick Creek	18.1	mining
		Craborchard Creek	18.8	mining
		Smith Ditch	1.7	mining
Ohio River	05090203	Ohio River	27.0	municipal waste, nonpoint source
		STATE TOTAL	**675.3**	

Hydrologic Unit Water Quality Ranking

The purpose of the hydrologic unit water quality ranking is to compare each of the U.S. Geological Survey cataloging unit watersheds in terms of overall water quality. Various sources of information and data have been combined with appropriate weighting to give a rating which ranks the watersheds from best to worst. The composite rank formula utilized is:

WQR = a(PCHEM) + b(FISH) + c(SUDS) + d(BIOL)

where: a, b, c and d are weighting constants which sum to 1.0.

WQR	Water Quality Rank.
PCHEM	Physical Chemical Rank - determined from the evaluation of fixed network monitoring data.
FISH	Fish Rank - based on a modified Karr Index primarily using Kentucky Department of Fish and Wildlife Resources studies.
SUDS	Stream Use Designation Rank - based on professional assessment of the degree of impact determined from intensive surveys.
BIOL	Biological Assessment Rank - determined by assessment of biotic, physicochemical, and habitat data from fixed station networks.

The weighting constants may be modified to evaluate the influence of the different variables and to arrive at a formula which accurately represents the relative importance and dependability of the individual ranking variables. Further refinement can be anticipated as additional data become available. Weighting constants utilized in this application of the equation are based upon judgment and the relative abundance of information in each category. The assigned weights are: a=0.3, b=0.1, c=0.3, and d= 0.3.

The following is a brief discussion of the development of each of the four ranking variables.

1) Physical-Chemical Index (PCHEM)

Physical-chemical index values were calculated for each of the water quality monitoring stations operated by the Kentucky Division of Water, and some stations operated by the Ohio River Valley Water Sanitation Commission, U.S. Army Corps of Engineers, and the U.S. Geological Survey during 1984-1985. Station locations can be found elsewhere in this report under the monitoring program discussion. Data for the two year period were compiled by the Geological Survey hydrologic unit. Thirty-one of Kentucky's 42 hydrologic units were evaluated.

The physical-chemical index is the reciprocal of the severity index, an index method developed by EPA and also used in this report for trend analysis. The severity index is described in Appendix A. The PCHEM index values were sorted in descending order, and a rank was developed. Percent values were then determined by dividing the rank by the number of hydrologic units and multiplying by 100. The resulting PCHEM index rank can range from 0 to 100, where higher values indicate better water quality than lower values. The median rank of 50 was assigned to hydrologic units where monitoring data are not available.

2) Fisheries Rank (FISH)

Ecological integrity has been described as the capacity of a system to support and maintain "a balanced, integrated, adaptive community of organisms having a species composition, diversity, and functional organization comparable to that of natural habitat" within a given geographic region (Ballentine and Quarrie 1975. The Integrity of Water: A Symposium. U.S. Environmental Protection Agency). To assess the component of stream biotic integrity, a classification system was proposed by Karr (Fisheries. 6(6):21-27. 1981). This classification of biotic integrity employs 12 fish community parameters. These parameters reflect the variables of species composition and richness, and functional organization as expressed by trophic structure of the community.

River system fishery inventories of the Kentucky Department of Fish and Wildlife Resources served as the primary source of information used in the classification. These were supplemented with Kentucky Nature Preserves Commission reports, recent literature, and environmental impact statements.

In the classification system, numerical rankings are given to each parameter (i.e. 1=very poor to absent, 3=median level or average presence, 5= very good or exceptional presence). A total numerical ranking is then achieved from the summation of the individual parameter rankings. The total numerical ranking is then applied to a descriptive classification of stream biotic integrity (i.e., good, fair, poor). In the present 305(b) document, a numerical ranking of greater than 46 is considered good, a ranking of between 37 to 45 is fair, and a ranking of less than 37 is poor. This is a modification of Karr's classification which included a greater number of biotic integrity types (i.e., excellent, very poor, etc.). A maximum numerical ranking of 60 is possible. In the current evaluation, when two or more sites were located on the longitudinal axis of the same stream and the classification of these sites differed, the mid-point between the sites was arbitrarily chosen as the limit of a given segment.

The sum of stream miles in each category was determined for each hydrologic unit and a simple formula was used to give each watershed a respresentative point value.

$$\frac{\text{miles of good - miles of poor}}{\text{total of good, fair and poor}}$$

The point value equation results in a number which ranges from minus one to plus one depending on the number of stream miles in each group. A percent ranking was then developed, similar to the PCHEM rank, resulting in a Fish Rank of the U.S. Geological Survey hydrologic units. For watersheds where literature data were not available or were insufficient, the median rank of 50 was assigned.

A total of 2,259 stream miles was characterized. This evaluation resulted in the identification of 92 miles with poor biotic integrity. The rating of poor reflected degradation of one or more of the variables (flow regime, water quality, habitat structure, energy source) which influence the biotic integrity of aquatic communities (Karr and Dudley, Environmental Management. 5(1):55-68; 1981).

3) Stream Use Designation Rank (SUD)

During 1984-1985, ten intensive surveys evaluating 364 miles were conducted to determine if streams were supporting their designated uses. In addition, data were evaluated from 22 surveys conducted in 1982-1983 that assessed 902 miles of streams. Since no major changes are known to have occurred in those areas, it was judged that the stream conditions remained the same. A total of 1,266 stream miles were assessed for use support during the period of 1982-1985.

The streams were assessed by evaluating the biological, bacteriological, physicochemical, toxicological and habitat data in concert with direct observation and professional judgment. The stream mileages were grouped into unimpaired, partially impaired, and impaired uses, and an unknown category.

The streams were considered to support designated uses (unimpaired) if no impacts or only minor impacts to the biotic integrity, physical habitat and water quality were observed. Streams were determined to be partially impaired when the data indicated stressed biotic communities, minor violations of water quality standards or some physical impairment to aquatic habitats. Impaired or non-supporting streams were those indicating severe stress, such as sustained species deletions, trophic imbalances in the biotic communities, chronic violations of water quality standards and severely reduced or eliminated aquatic habitats.

Of the 1,266 miles of streams assessed, 518 miles (41 percent) supported their designated uses, 286 miles (23 percent) partially supported their uses, 462 miles (36 percent) did not support designated uses, and 386 miles were unknown or data were limited and an appropriate assessment could not be made.

As in the previous calculation, a simple formula was used to give each hydrologic unit a representative point value.

$$\frac{\text{miles unimpaired - miles impaired}}{\text{total miles studied}}$$

The same ranking procedure was used. Hydrologic units which had not been studied received the median rank of 50.

4) Biological Assessment Rank (BIOL)

Biological data for 1984-1985 were collected from 26 fixed stations throughout the state. Biotic, physicochemical and habitat data, along with direct observation and professional judgment, were used to make determinations on use support. In addition to the 1984-1985 data, some station assessments were made from biological data that spanned five or more years. Streams were considered unimpaired if information reflected no alterations in community structures or functional compositions for the available habitats, and if habitat conditions were relatively undisturbed for the miles assessed. Streams were categorized as partially impaired if information revealed that community structures were slightly altered, that functional feeding components were noticeably influenced, or if available habitats reflected some alterations and/or reductions for the miles assessed. Streams were considered impaired if information reflected sustained alterations or deletions in community structures, taxa richness and functional feeding types, or if available habitats were often severely reduced or eliminated for the miles assessed.

Of the 724 miles assessed by biological information, 265 miles (37 percent) were unimpaired and supporting their designated use, 322 miles (44 percent) were partially impaired and 137 miles (19 percent) were impaired and considered not to support their designated uses.

The BIOL value was determined using the same equation and percent ranking procedure as that used for SUDS.

The resultant hydrologic unit water quality ranking is presented in Table 3. This table lists the hydrologic units ranked from best to worst water quality, and provides the individual rankings for each of the four categories. In the case of ties, the average percent rank was used (for example, five hydrologic units have a value of 90.5 in the FISH category). There was a sufficient data base to perform the analysis on 31 hydrologic units representing most of the state as shown in Figure 9.

The seven hydrologic units reflecting the poorest water quality contain 58 percent of the streams listed in Table 2. These hydrologic units include: Mud River and Pond River within the Green River basin, the northern half of the Salt River basin, upper mainstem of the Kentucky River basin including the Red River, Tug Fork and Blaine Creek within the Big Sandy River basin, and the Little Sandy River.

It should be noted that Kentucky River segment 05100204 exhibited the most dramatic reversal in ranking from the previous 305(b) report. This hydrologic unit was ranked as the fourth best in the 1984 report and as the third worst in the 1986 report. The reason for this change is attributed to the expanded data base resulting from the Division of Water's focus on the oil and gas production impacts on streams in the Big Sinking Oil Field within this basin.

Further discussion concerning water quality impacts, causes, and agency actions can be found in latter sections of this report.

Trends in Water Quality

A water quality trend analyses was performed on an annual severity index for stations that have been regularly sampled since 1980. The annual severity index was developed by EPA for use by states in their reports to Congress. A description of this method and the parameters used in the analysis are presented in Appendix A.

A severity index was calculated for each year from 1980 to 1985. Stations with low or zero values indicate better water than those with the largest values, which indicate water quality problems. The series of values was then tested for trend, using Kendall's Tau Test. This test is a non-parametric statistical method that compares a data set to determine if the data tend to track together. The data, in this case the annual severity index, are compared over time to determine if the data have an increasing or decreasing tendency. The significance level of the test is measured using Kendall's K. If the significance level is greater than 0.05 (the 95 percent confidence limit), then the trend is not considered statistically significant. The magnitude of the trend is determined by finding the median of the slopes of straight lines fitted to all possible pairs of observations.

Table 3

Hydrologic Units Ranked in Order
of Highest Water Quality

Hydrologic Unit	Ident.* No.	WQR	P. Chem. (wt=0.3)	Fish (wt=0.1)	SUDs (wt=0.3)	Biol. (wt=0.3)
05100203	1	75.0	84.6	71.4	50.0	91.7
05110001	2	73.2	73.1	76.2	73.3	72.2
05130102	3	71.2	65.4	90.5	100.0	41.7
05130205	4	65.0	100.0	50.0	50.0	50.0
05100101	5	65.0	34.6	52.4	86.7	77.8
05130104	6	63.3	80.8	90.5	50.0	50.0
05090103	7	63.0	50.0	50.0	93.3	50.0
05110002	8	61.8	76.9	57.1	60.0	50.0
05090201	9	61.3	50.0	38.1	50.0	91.7
05130103	10	60.9	96.2	90.5	26.7	50.0
05100205	11	57.7	42.3	50.0	66.7	66.7
05110004	12	56.7	30.8	50.0	66.7	91.7
05100202	13	55.5	88.5	14.3	50.0	41.7
05140205	14	54.1	92.3	19.0	40.0	41.7
05140203	15	54.0	50.0	90.5	50.0	50.0
06040006	16	53.3	69.2	50.0	50.0	41.7
08010201	17	52.1	15.4	50.0	50.0	91.7
05110005	18	50.6	57.7	33.3	50.0	50.0
05100201	19	48.7	50.0	61.9	50.0	41.7
05130101	20	48.7	53.8	50.0	50.0	41.7
05100102	21	48.6	15.4	50.0	80.0	50.0
05140202	22	46.0	50.0	9.5	50.0	50.0
05140103	23	42.3	25.0	47.6	50.0	50.0
05070203	24	40.0	25.0	50.0	50.0	41.7
05070204	25	37.8	3.8	66.7	50.0	41.7
05110006	26	37.5	15.4	28.6	50.0	50.0
05090104	27	36.4	50.0	23.8	13.3	50.0
05070201	28	34.8	7.7	50.0	50.0	41.7
05100204	29	32.2	46.2	90.5	20.0	11.1
05140102	30	27.0	38.5	4.8	33.3	16.7
05110003	31	26.4	61.5	42.9	6.7	26.4

*Identification number locates hydrologic unit on Figure 9.

Water Quality Rank by Hydrologic Unit

Numbers correspond with relative ranking shown in Table 3

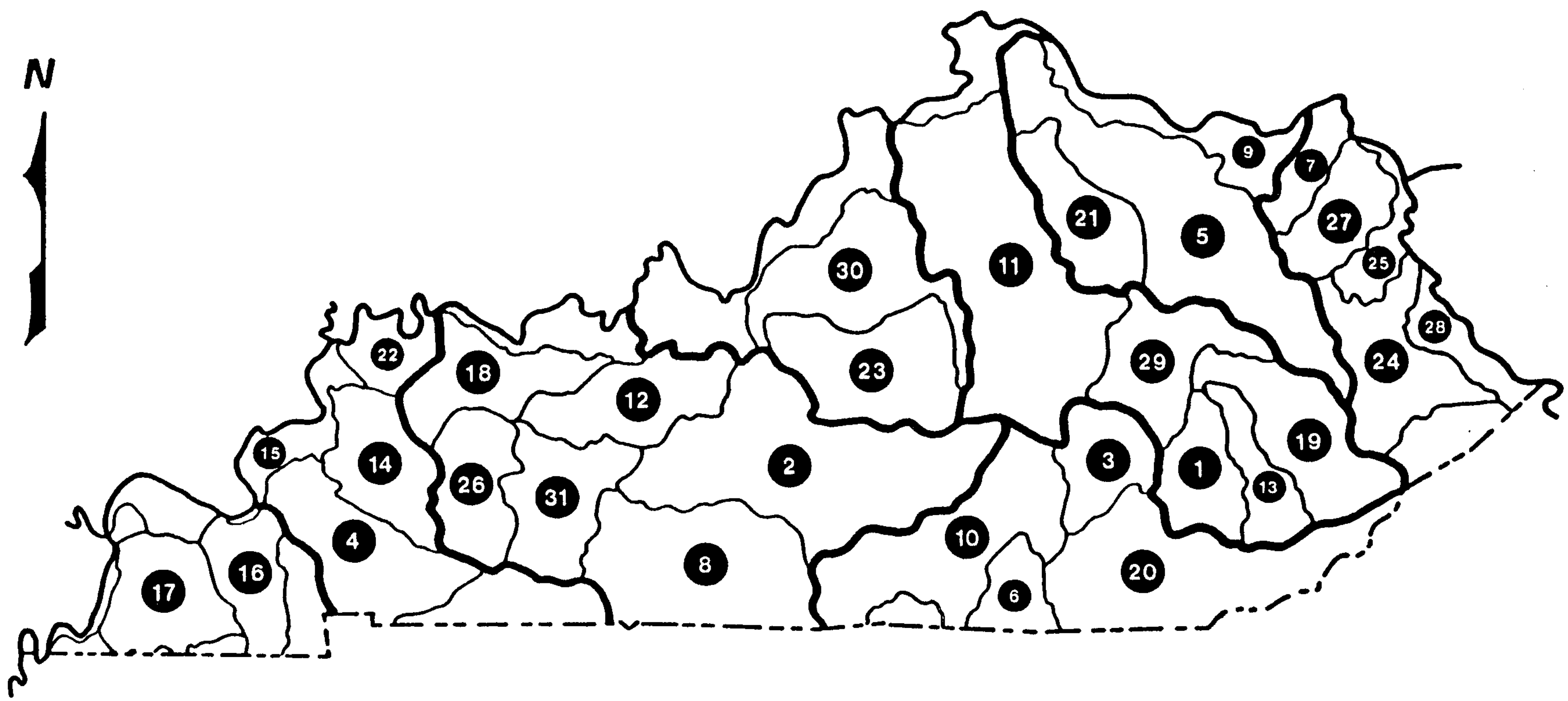

Figure 9

Results of the trend analysis presented in Table 4 indicate that there were no stations with declining water quality over the period assessed. Five stations show improving water quality during the past six years. Pond Creek near Louisville shows the most dramatic improvement in the state, yet this stream is still the poorest in quality of all the stations sampled. Total phosphorus is the most persistent problem in the basin, and shows the most improvement. This is likely the result of efforts by Jefferson County to eliminate package sewage treatment plants throughout the county. The Kentucky River at Camp Nelson and the Kentucky River below Frankfort indicate some improvement in phosphorus, fecal coliform bacteria, and iron. Suspended solids and iron show improvement in the Nolin River at White Mills. The South Fork of the Cumberland River shows improvement in cadmium and fecal coliform bacteria.

Several factors should be considered when reviewing this analysis. The six years (and thus six values) are the minimum number of values needed to perform this test. Stream flow can effect water quality and methods to account for this were not attempted in this report. Lastly, the severity index is based on a specified set of parameters. If there is an increase or a decrease in the number of parameters used, the index value will change accordingly. Thus the index value, standing alone, should not be used as an indicator of "good" or "poor" quality. With these limitations in mind, the severity index and trend analysis are considered accurate and reliable methods for comparing water quality conditions throughout Kentucky.

Relative Causes of Use Non-support

Table 5 provides a summary of the relative causes of use impairment statewide from various sources for the 675.3 miles of waters assessed as not supporting designated uses.

Table 5

Relative Causes of Use Non-support

Cause	Miles Not Supporting Uses	Percent
Municipal Sources	131.8	19.5
Mining	197.8	29.3
Oil Brine	170.0	25.2
Other Industrial Sources	175.7	26.0
TOTAL	675.3	100.0

Table 4

Water Quality Trend Analysis

Station	Severity Index						Stream Miles Assessed	Water Quality Trend	Problem Parameters
	1980	1981	1982	1983	1984	1985			
Hydrologic Unit 05070201									
Tug Fork at Freeburn	1.42	1.54	1.16	1.27	0.93	11.99	38	No trend	bacteria, iron, SS*
Tug Fork at Kermit	2.01	4.12	3.32	1.66	6.29	4.47	56	No trend	SS, bacteria, iron
Hydrologic Unit 05070203									
Levisa Fork at Pikeville	2.07	2.96	3.55	1.62	3.51	1.50	35	No trend	SS, bacteria, iron
Levisa Fork at Paintsville	1.01	2.61	2.71	2.11	6.59	4.43	25	No trend	bacteria, SS, iron
Hydrologic Unit 05070204									
Blaine Cr. at Fallsburg	3.81	3.20	3.93	1.63	4.23	ND	24	No trend	chloride, iron, SS
Big Sandy at Louisa	3.74	2.21	6.38	1.76	3.31	2.14	6.8	No trend	SS, bacteria, phosphorus
Hydrologic Unit 05100101									
North Fork Licking R. near Lewisburg	1.93	3.28	6.58	0.84	3.27	0.66	19.5	No trend	phosphorus, iron, bacteria
Licking R. at Butler	2.75	4.88	1.84	3.17	2.57	4.44	44.0	No trend	phosphorus, bacteria, SS
Hydrologic Unit 05100204									
Kentucky R. at Heidelberg	0.95	10.46	4.06	1.33	2.65	.69	33.7	No trend	iron, SS, phosphorus
Red R. at Hazel Green	3.52	3.95	1.65	1.33	2.60	2.43	29.0	No trend	bacteria, iron, SS
Hydrologic Unit 05100205									
Kentucky R. at Camp Nelson	3.32	2.40	2.93	1.52	1.62	0.79	37.7	Improving quality	phosphorus, iron, bacteria

Table 4

Water Quality Trend Analysis (continued)

Station	Severity Index 1980	1981	1982	1983	1984	1985	Stream Miles Assessed	Water Quality Trend	Problem Parameters
Hydrologic Unit 05100205 (continued)									
Kentucky R. above Frankfort	5.30	2.35	3.06	2.02	2.58	0.33	15.2	No trend	phosphorus, iron, SS, cadmium
Kentucky R. below Frankfort	3.60	3.33	3.21	3.12	2.49	0.78	23.0	Improving quality	phosphorus, iron, SS, cadmium
Kentucky R. Lockport	1.94	3.67	1.37	4.59	2.16	0.66	31.0	No trend	phosphorus, bacteria, SS
Eagle Cr. at Glencoe	2.00	3.01	2.05	2.36	3.93	3.03	27.2	No trend	phosphorus, iron, SS
Hydrologic Unit 05140102									
Salt R. at Shepherdsville	5.25	4.20	5.87	4.21	3.22	3.10	13.9	No trend	phosphorus, bacteria
Pond Cr. near Louisville	18.45	21.19	20.48	18.52	16.92	13.94	21.8	Improving quality	phosphorus, bacteria, iron, zinc
Hydrologic Unit 05140103									
Rolling Fork near Lebanon Junction	3.82	5.02	6.03	5.48	6.87	2.21	20.1	No trend	phosphorus, SS, bacteria
Hydrologic Unit 05110001									
Green R. at Greensburg	0.52	1.76	1.09	0.31	1.53	0.16	78.3	No trend	bacteria, iron
Green R. at Munfordville	0.55	2.32	1.16	0.42	1.43	0.28	37.8	No trend	bacteria, SS, iron
Nolin R. at White Mills	1.72	2.36	1.98	1.86	1.28	1.23	28.0	Improving quality	phosphorus, bacteria
Bacon Cr. near Priceville	0.74	0.42	ND	0.36	0.56	0.0	14.0	No trend	bacteria

Table 4

Water Quality Trend Analysis (continued)

Station	Severity Index 1980	1981	1982	1983	1984	1985	Stream Miles Assessed	Water Quality Trend	Problem Parameters
Hydrologic Unit 05110002									
Barren R. at Bowling Green	0.85	1.47	2.30	1.15	1.36	0.17	6.5	No trend	iron, copper, SS
Hydrologic Unit 05110003									
Green R. at Aberdeen	0.95	0.87	3.23	1.17	1.38	0.62	31.1	No trend	iron, phosphorus, SS
Mud R. near Lewisburg	2.80	5.48	4.69	2.12	1.43	2.04	21.4	No trend	phosphorus, SS, bacteria, DO
Hydrologic Unit 05110004									
Rough R. near Dundee	0.68	4.96	3.65	1.95	1.22	4.70	59.0	No trend	iron, SS, phosphorus
Hydrologic Unit 05110005									
Green R. near Beech Grove	1.96	1.17	1.24	4.24	1.52	0.0	54.0	No trend	SS, phosphorus, bacteria
Hydrologic Unit 05110006									
Pond R. near Apex	1.50	2.65	5.40	2.62	1.81	7.31	22.5	No trend	iron, SS, phosphorus
Pond R. near Sacramento	3.09	2.39	4.54	3.37	3.39	4.59	29.9	No trend	zinc, iron, phosphorus, SS

Table 4

Water Quality Trend Analysis (continued)

Station	Severity Index 1980	1981	1982	1983	1984	1985	Stream Miles Assessed	Water Quality Trend	Problem Parameters
Hydrologic Unit 05130101									
Cumberland R. at Pineville	2.42	2.71	4.94	4.17	2.39	2.06	75.0	No trend	bacteria, SS, iron, phosphorus
Cumberland R. at Cumberland Falls	1.23	3.61	3.05	2.18	2.77	0.66	21.2	No trend	SS, iron, phosphorus, bacteria
Hydrologic Unit 05130102									
Rockcastle R. at Billows	0.0	1.73	0.0	0.74	0.37	0.84	29.0	No trend	zinc, SS, copper, iron
Hydrologic Unit 05130103									
Cumberland R. at Burkesville	0.22	0.56	0.23	0.79	0.44	0.0	17.4	No trend	bacteria, zinc
Hydrologic Unit 0513103									
South Fork Cumberland R.	2.40	1.42	1.15	0.92	1.12	0.40	14.9	Improving quality	iron, SS, cadmium
Hydrologic Unit 05130205									
Cumberland R. near Grand Rivers	0.88	0.38	0.68	0.22	0.29	0.58	29.4	No trend	phosphorus, SS

*SS-Suspended Solids

Relative Assessment of Major Pollutants

Evaluation of physicochemical, biological and intensive survey data resulted in six categories of pollutants considered to be of major concern. The establishment of these categories and parameters of concern are based on violations of state water quality standards, recommended EPA criteria or Food and Drug Administration (FDA) action levels in fish tissues. The categories and specific parameters of concern are:

Category	Parameter
Heavy Metals	Iron, Lead, Copper, Zinc
Bacteria/Pathogens	Fecal Coliform
Turbidity/Total Suspended Solids	Total Suspended Solids
Nutrients	Total Phosphorus
Pesticides/Organics	Polychlorinated Biphenyls (PCB's), Chlordane
Salinity/Total dissolved solids	Chloride

- **Metals** - The metals listed as parameters of concern are based on their continued presence in concentrations above state water quality standards or recommended EPA water quality criteria. The sources of the metals are difficult to determine because metals are associated with both point and nonpoint sources. Iron is associated with sediment and is probably high in Kentucky waters because of surface disturbances from surface mining and agricultural activities.

- **Bacteria and Pathogens** - Violations of the fecal coliform standard during the primary contact recreation season (May-October) are of concern because the increased levels of fecal coliform are associated with an increase in waterborne illness. The primary causes for excessive (greater than 400 colonies per 100 milliliters) levels are improperly operating wastewater treatment plants, direct pipe discharges, septic tank leachate and agricultural runoff during wet weather events.

- **Suspended Solids** - The concentration of suspended solids in water is of concern because it affects light penetration, temperature, adsorbing and solubility capabilities, and habitat condition. Suspended solids can also damage aquatic life by mechanical and abrasive action. Major contributions can be attributed to the lack of nonpoint sediment controls and minor site-specific impacts from poorly treated point sources. The level of impact varies according to land use, gradient, vegetation and soil types.

- **Nutrients** - Phosphorus as phosphate is one of the major nutrients required for algal nutrition. Excess amounts can cause nuisance algal blooms and the proliferation of taste and odor producing algae in drinking water sources. Phosphorus occurs in municipal wastewater and nonpoint agricultural runoff.

- **Organics/Pesticides** - PCBs are of major concern because fish tissue concentrations exceeded FDA action levels of 2.0 mg/kg in 115 miles of streams. Sources of the PCBs were identified as two industrial discharges.

  Chlordane (a chlorinated hydrocarbon pesticide) has shown increased levels in fish tissue in urban streams and those streams draining urban areas. The source is thought to be pest control activities in urban areas.

- **Salinity/Dissolved Solids** - Chloride in oil brine has been identified as a major pollutant from oil production operations. Chloride levels greater than 600 mg/l in streams within the oil producing regions of the state are not uncommon. The elevated chloride levels have detrimental impacts on aquatic life and domestic water supplies.

An additional problem category not included in the above ranking is low pH from acid mine drainage. The regional impacts of low pH levels associated with acid mine drainage from coal mining occur predominantly in the western portion of the state. Acid mine drainage impacts on water quality in western Kentucky streams are assumed to remain unchanged. Although over 550 miles of stream in the western portion of the state were judged to be impacted by low pH levels in 1981, program priorities have not focused on this chronic water quality problem.